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To: The File

From: Contracting Officer

Subject: Contract No. OR910-CT6-1111, Remote Sensing

The original remote sensing report and supporting documentation, completed by Econ, Inc., as a result of the subject contract is filed in RMS, subject function code 9163, Remote Sensing. All project photography is located in the Cartographic Section (942).

/s/ G. Joan Betts

G. Joan Betts
Contracting Officer

cc: Paul Vetterick, OR910
Larry Walker, OR932
Bob Wright, OR955
Tom Aufenthie, OR931
Ted Albert, OR942
Jack Albright, Larry Taylor, Baker Resource Area
w/copy of final report for your review and retention
RMS, w/original and unbound camera-ready copy.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

OREGON STATE OFFICE
P.O. Box 2965 (825 NE Multnomah Street)
Portland, Oregon 97208

IN REPLY
REFER TO:

1512(952)

September 23, 1987

TO: Paul Vetterick, 910
Tom Aufenthie, 931
Fred Batson, DSC
Bob Wright, 955

FROM: G. Joan Betts, Contracting Officer

SUBJECT: Contract No. OR910-CT6-1111, Remote Sensing, ECON, Inc.

Enclosed is a copy of the final Remote Sensing report by ECON, Inc. They presented the report with backup data (photos, interpretation tally forms, infrared video tapes, and plantation stocking survey summary and analysis forms) to this office on September 22. Attending the meeting with Econ were COR Jack Witherspoon, Larry Walker, Tom Aufenthie, Ted Albert, Carl Pearson, and the Contracting Officer.

This report is provided to you for your review. Please address any comments you may wish to make to this office as soon as possible as we do intend to make final acceptance of the report quickly. If necessary, further discussions can be arranged with Econ.

This copy is for your retention should you desire to maintain a copy, otherwise, please return it to this office for filing with the master file. Should you desire to review the backup data, it will be maintained in this office until we accept the report. You will then be notified of the final location of the entire file for future reference.

G. Joan Betts

cc: Jack Witherspoon
Larry Walker, 931
Ted Albert

ECON
ECOLOGICAL CONSULTING SERVICE

ECON INC.
130 Neill Ave.
Helena, Montana 59601
Telephone
406/442-4650

September 22, 1987

Ms. G. Joan Betts
Contracting Officer
USDA Bureau of Land Management
Oregon State Office
P.O. Box 2965 (825 NE Multonomah Street)
Portland, Oregon 97208

Ref.: Contract No. OR910-CT6-1111
"Remote Sensing of Forest and Range Conditions in Western and Eastern Oregon"

Dear Ms. Betts:

We are hand-delivering to you today eight (8) bound copies of the Final Report; one (1) unbound camera-ready copy of the Final Report; and one (1) set of Appendices A through H (5 volumes) of the above referenced project. We are also hand-delivering two (2) original 1/2" VHS videotapes containing color infrared coverage of the forestry and range study areas.

The results of this project demonstrate that a practical, affordable application to range monitoring is possible. The results also show that competing vegetation limits the potential for seedling monitoring in forest plantations, but also reveal a useful application during winter leaf-off on older plantations where shadow coverage is minimal.

We wish to express our deep appreciation for the cooperation and assistance we have received from you, Paul Vetterick, Jack Witherspoon, Tom Aufenthie, Larry Walker, Larry Taylor, Gordon Staker, Craig Kintop, John DePuy, Ron Andersen and all the many other BLM personnel we had the pleasure of meeting and working with.

We also wish to express our gratitude to Merle P. Meyer, Ph.D., Project Advisor and Technical Director, who's expertise and support were invaluable.

Sincerely,

ROBERT E. CARROLL
President

JEFFREY T. RYAN
Projects Manager

PHILLIP W. JOHNSON
Principal Investigator

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cc: file 400
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REMOTE SENSING OF FOREST PLANTATIONS IN WESTERN OREGON TO TEST THE FEASIBILITY OF USING LARGE SCALE AERIAL PHOTOGRAPHY AS A TOOL TO MONITOR STOCKING CONDITIONS

Contract No. OR910-CT6-1111

Project 400

Prepared For

USDI, Bureau of Land Management
Oregon State Office
P. O. Box 2975
Portland, Oregon 97208

September 18, 1987

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Prepared By

ECON INC.
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Appendix F. Plantation Site Photo Interpretation Tally Forms.

Appendix G. Plantation Stocking Survey Summary and Analysis Forms.

Appendix H. Plantation Sketch Maps Depicting Adequate Versus Inadequate Stocking.

I. OBJECTIVES

The objective of this project is to develop a remote sensing system (or systems) for analyzing the adequacy of conifer stocking on forest plantations in western Oregon. The system is designed to detect the following attributes in a manner such that they can be compared over time: total and average numbers of trees per acre, type of species and extent of interfering vegetation, and the extent of nonproductive land within each plantation.

After preliminary evaluation of several types of imagery and imagery interpretation techniques, it was determined that conventional 9"x9" aerial photography and manual interpretation techniques were the most suitable approaches for evaluating the adequacy of conifer stocking of forest plantations in western Oregon.

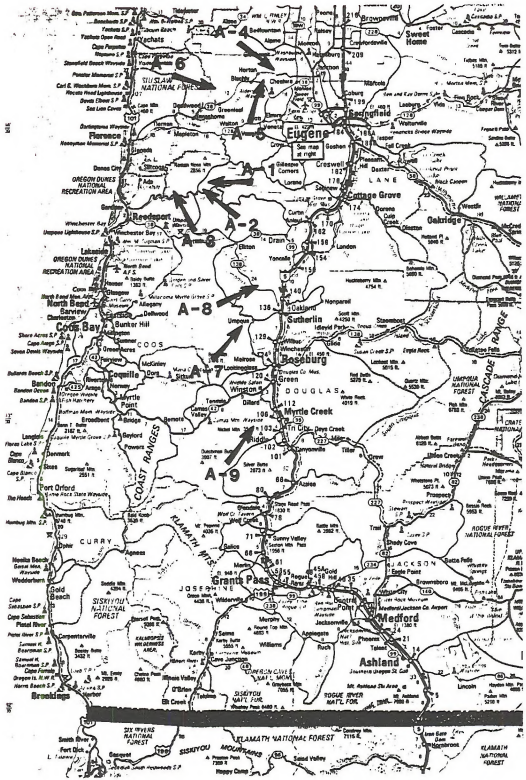
II. STUDY AREA DESCRIPTIONS

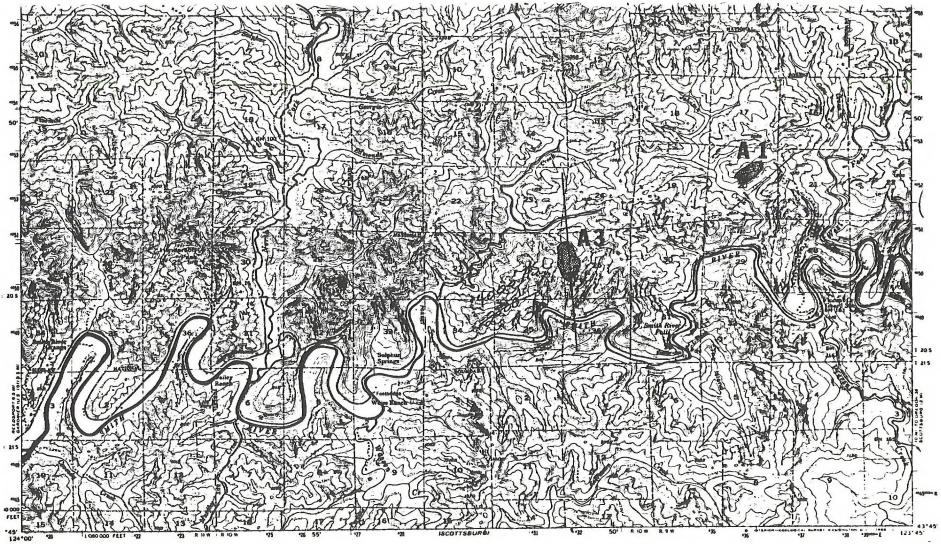
Nine plantation study sites were selected along the Pacific Coast Range, in a band from Eugene south to Roseburg (see Figure 1 and accompanying 1:15,000 general location maps). Three restocked plantations were chosen from the Eugene, Roseburg, and Coos Bay BLM Districts. From each district, a pre-establishment (1- to 3-year-old), establishment (4- to 7-year-old), and backlog (8+ years) plantation was selected for inclusion in this study.

For the most part, each of the plantation sites occur over very steep, mountainous terrain. Average annual rainfall for the region ranges between 50 and 70 inches, coming chiefly during the winter months. It would be difficult to establish precise rainfall amounts for each plantation, given the localized weather patterns typical of mountainous landscapes. Of the three districts, the Roseburg area appears the driest, followed by Eugene and Coos Bay.

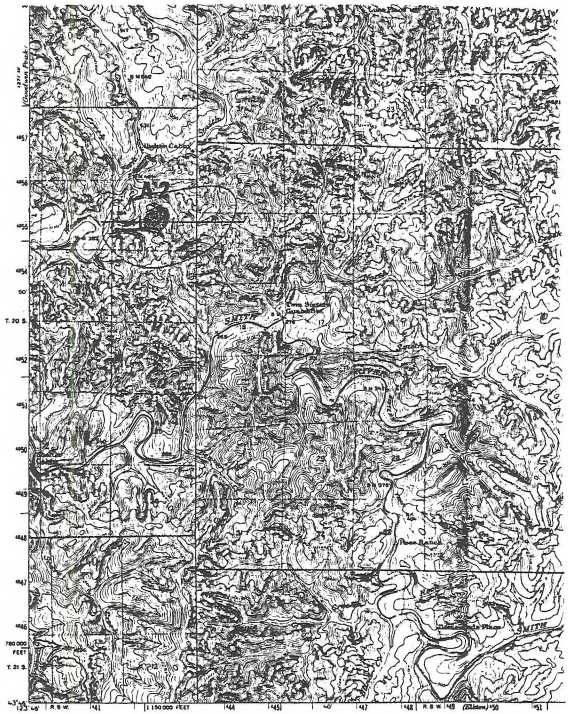
Sites were present on all possible aspect, slope angle, and topographic positions. Elevations ranged from 500' to 1,500' ASL. Some plantations were situated entirely on one sideslope, while others possessed contrasting aspects. Typically, the plantations were surrounded on three or more sides by mature forests.

Adjacent, uncut forests are typically closed canopy with thick, well-developed shrub understories. Following timber (overstory) removal, these broadleaf tree and shrub species remain as sole competitors for available water and light (the primary limiting factor in plant growth), impeding the re-establishment and survival of restocked conifers.

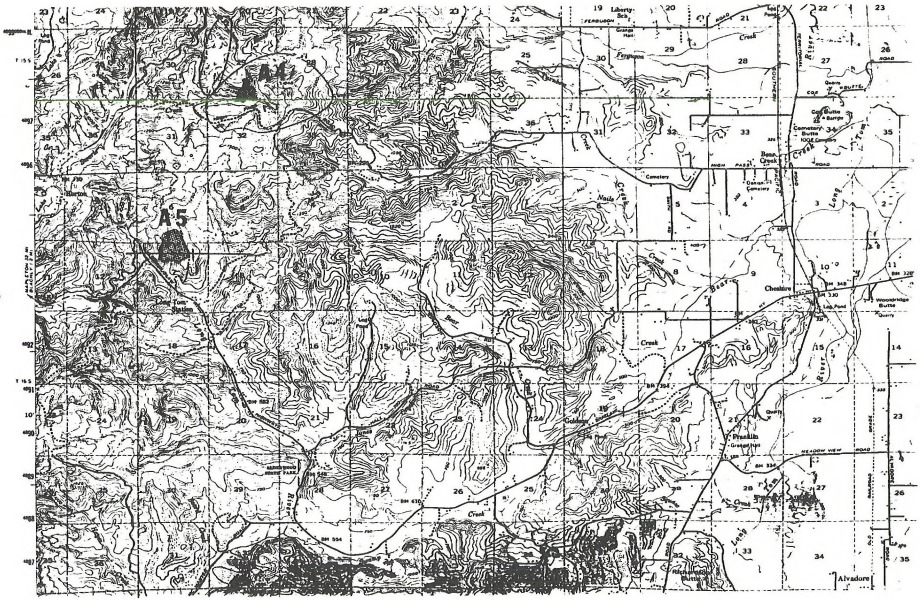

A-4
A-5
A-6
A-1
A-2
A-8
A-7
A-9
Eugene
Springfield
Florence
Reedsport
Coos Bay
North Bend
Roseburg
Myrtle Creek
Grants Pass
Medford
Ashland
Brookings
Cottage Grove
Oakridge
Sweet Home
Lebanon
Albany
Corvallis
Coquille
Bandon
Port Orford
Gold Beach
Sutherlin
Winston
Drain
Yoncalla
Elkton
Oakland
Sisters
Redmond
Bend
Klamath Falls
Tillamook
Newport
Lincoln City
Toledo
Siletz
Waldport
Yachats
Florence
Dunes City
Gardiner
Reedsport
Winchester Bay
Lakeside
Coos Bay
North Bend
Charleston
Bunker Hill
Coquille
Bandon
Myrtle Point
Broadbent
Powers
Langlois
Sixes
Agness
Port Orford
Gold Beach
Brookings
Harbor
Wedderburn
Pistol River
Carpenterville
Crescent City
Smith River
Fort Dick
Gasquet
Hiouchi
Cave Junction
Illinois Valley
Kerby
Takilma
Selma
Galice
Merlin
Glendale
Azalea
Canyonville
Riddle
Days Creek
Tiller
Glide
Idleyld Park
Steamboat
Umpqua
Nonpareil
Scottsburg
Elkton
Drain
Yoncalla
Creswell
Cottage Grove
Dexter
Lowell
Oakridge
Westfir
Blue River
McKenzie Bridge
Vida
Leaburg
Walterville
Coburg
Junction City
Monroe
Harrisburg
Halsey
Shedd
Brownsville
Lebanon
Scio
Mill City
Gates
Detroit
Idanha
Marion Forks
Santiam Jct.
Sisters
Redmond
Bend
Prineville
Madras
Culver
Metolius
Terrebonne
Tumalo
Alfalfa
Powell Butte
Crooked River Ranch
Grizzly
Camp Sherman
Black Butte Ranch
Sisters
Suttle Lake
Hoodoo Ski Area
Santiam Pass
Big Lake
Belknap Springs
McKenzie Pass
Dee
Parkdale
Hood River
Mount Hood
Government Camp
Rhododendron
Zigzag
Welches
Sandy
Estacada
Molalla
Canby
Oregon City
Gladstone
Milwaukie
Portland
Vancouver
Longview
Kelso
Woodland
Ridgefield
Battle Ground
Camas
Washougal
Troutdale
Gresham
Sandy
Estacada
Molalla
Silverton
Stayton
Sublimity
Scotts Mills
Aumsville
Turner
Salem
Keizer
Woodburn
Hubbard
Aurora
Donald
Newberg
Dundee
McMinnville
Amity
Dallas
Falls City
Independence
Monmouth
Rickreall
Grand Ronde
Willamina
Sheridan
Dayton
Yamhill
Carlton
Gaston
Forest Grove
Cornelius
Hillsboro
Beaverton
Tigard
Tualatin
Wilsonville
Lake Oswego
West Linn



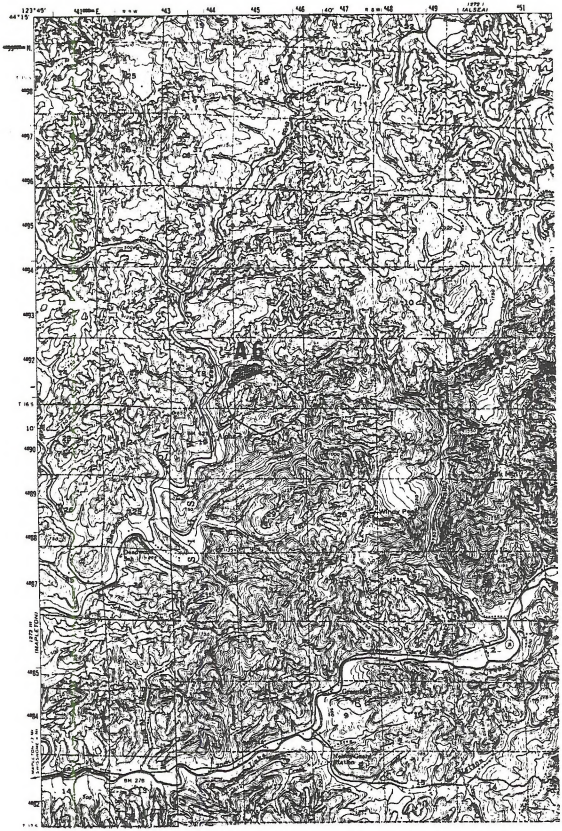
Goodwin Peak Quadrangle – Coos Bay District
Study Sites: A-1 Pre-establishment, A-3 Backlog



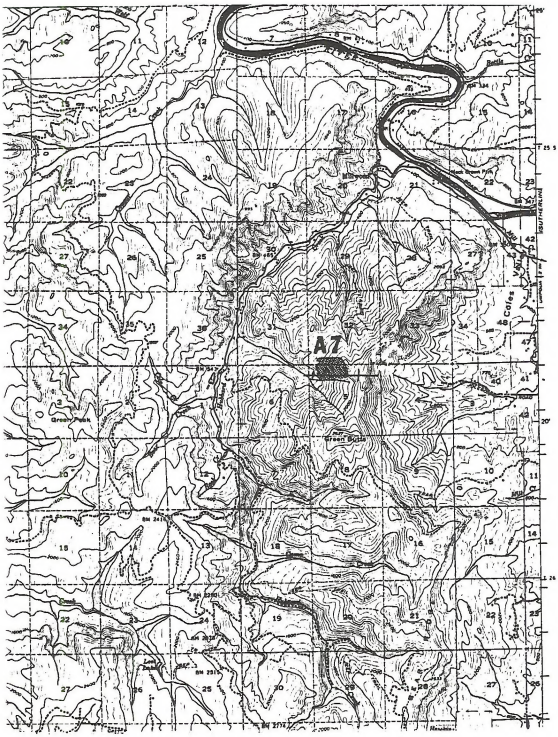
Roman Nose Mountain Quadrangle - Coos Bay District
Study Site: A-2 Establishment



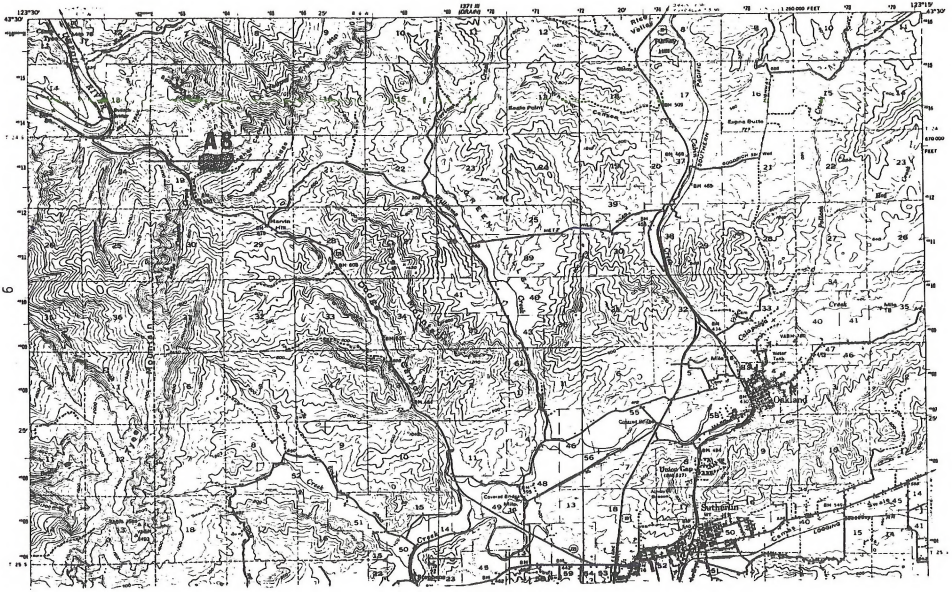
Elmira Quadrangle – Eugene District
Study Sites: A-4 Pre-establishment, A-5 Establishment



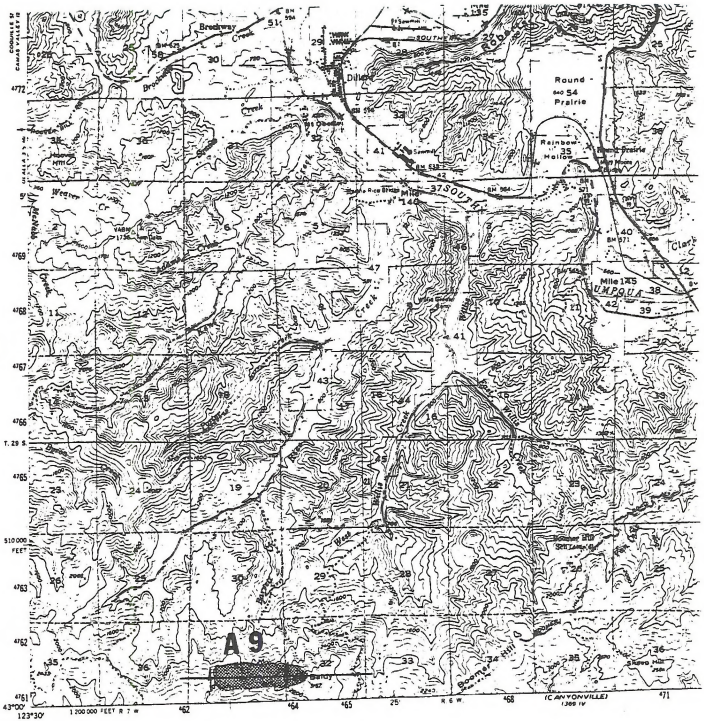
Blachly Quadrangle – Eugene District
Study Site: A-6 Backlog



Tyee Quadrangle - Roseburg District
Study Site: A-7 Pre-establishment



Sutherlin Quadrangle – Roseburg District
Study Site: A-8 Establishment



Roseburg Quadrangle - Roseburg District
Study Site: A-9 Backlog

III. REMOTE SENSING PARAMETERS

A. LARGE FORMAT AERIAL PHOTOGRAPHY

1. Acquired September 8, 1986 at Coos Bay, Eugene, and Roseburg

Nature of Acquired Coverage:

Film/filter combinations:
Aero Ektachrome IR 2443/Wratten 12
Color Negative 2445/Haze

Camera characteristics:
Fairchild KA-2
12-inch focal length
9x9-inch format

Nominal photo scale:
1:3,000 (average photo scale of plots at 3,000' above datum)

Photo quality:
(a) Steroscopic coverage:
Acceptable.

(b) Image quality:
Coos Bay - True color, good; CIR, good
Eugene - True color, good; CIR, good
Roseburg - True color, good; CIR, good

2. Acquired February 24, 1987 at Coos Bay, Eugene, and Roseburg

Nature of Acquired Coverage:

Film/filter combinations:
Aero Ektachrome IR 2443/Wratten 12
Color Neg 2445/Haze

Camera characteristics:
Fairchild KA-2
12-inch focal length
9x9-inch format

Nominal photo scale:
1:3,000 scale (average photo scale of plots at 3,000' above datum)

Photo quality:
(a) Steroscopic coverage:
Acceptable. A few plots had marginal or no stereo coverage.

(b) Image quality:
Coos Bay - CIR, good; true color, good
Eugene - CIR, good; true color, good
Roseburg - CIR good; true color, good

B. COLOR INFRARED VIDEO

Coast Range Douglas Fir Regeneration Sites

Color infrared video coverage of the nine forest plantation sites was accomplished on March 6, 1987. All sites were video taped with an approximate width of coverage of one-half mile. Two sites were also flown at narrower width of coverage (i.e., approximately one-third mile). Navigation was by visual means after finding the general site area using LORAN-C. The data was acquired using a BIOVISION color infrared video camera and recorded on VHS standard video tape. The video camera used has been specially modified to allow interactive color balance adjustments (i.e., adjustments in infrared sensitivity) while airborne, and this feature was utilized during the mission. Weather conditions were good, and the equipment functioned adequately with the exception of the audio interface with the aircraft intercom system.

Inspection of the video imagery indicates that the relatively low resolution provided by standard video systems was not adequate for monitoring Douglas fir regeneration under these conditions. Seedlings (i.e., less than 6 years) could not be readily separated from the background of slash, litter, and deci duous shrubs in a leaf-off condition. It was not possible to count individual seedlings, and the video image provided only a general indication of the extent of vegetative cover on the sites. As the trees became larger, performance improved somewhat, but we cannot conclude that the current state of airborne video provides a viable means of assessing regeneration success of Douglas fir.

It is our conclusion that for detailed measurement of regeneration success, conventional color infrared aerial photography would probably be more appropriate than airborne video, given the current state of video technology. However, video technology is evolving rapidly, and it is recommended that this experiment be repeated at some point in the future when technical improvements in camera and video tape technology warrant it. We are of the opinion that the concept of using video as a supplement to conventional aerial photography for regeneration surveys such as this is a valid one, but the technology is not quite yet up to the task.

The 1/4-mile-wide coverage showed some obvious features (i.e., general color and texture patterns). From ECON's previous experimentation with aerial video, including the prototype color infrared camera, some additional comments can be made.

The low resolution requires a rather large size threshold for target objects. At the present time, current thresholds are too high for the smallest units required for successful interpretation. Thus, seedlings forming the smallest-unit interpretation criteria could not be seen.

Discussions with commercial television personnel (broadcast-quality) revealed that adequate improvement is not coming in the immediate future. Visual interpretation is limited by the resolving capability of TV monitors, as well as the sensors. Currently, the U.S.A. standard is based on 525 lines with 1175 lines, or so-called high resolution, "waiting in the wings." Yet, even this improvement will not be enough to discriminate targets of small size, such as young seedlings.

Aerial video, at its present capabilities however, is useful for what might be termed general reconnaissance. In late 1987, a version of one-half-inch VHS called "Super VHS" may be marketed. It is expected to significantly improve the quality of one-half-inch VHS recordings, but will not solve the fundamental resolution problem..

In perhaps 7-10 years, technological advances may result in low cost equipment with sufficient resolution to compete with standard metric (9"x9") aerial photography. Rumors of military remote sensing resolution capabilities circulate and cause speculation, but even if such rumors were totally factual, the cost would prohibit general usage.

We would also like to address the status and capabilities of recently developed, automated interpretation techniques to resource inventories. V. Jaffe (1986) described spectral characteristics of plant canopies and listed the imaging spectrometer sensors in operation, under construction, and proposed by NASA. She states that "most studies correlating ground and satellite reflectances have concentrated on annual agricultural crops. Understandably, landscape heterogeneity and canopy complexes make measurement over natural and forested areas subject to uncertain interpretation." R. H. Haas and F. A. Waltz (no date) comment that Thematic Mapper (TM) and Multi Spectral Scanner (MSS) data "generally indicate a need for better spectral and spatial resolution to accomplish most resource assessment tasks."

At this time, aerial multispectral applications may be appropriate to determining the presence/absence of homogenous monocultures on relatively flat land and, to a degree, allow prediction of total green biomass over a large area. This synoptic application is not suitable for providing the high resolution of the smallest item units (i.e., seedlings) with fine textural distinctions. Another major operational drawback is economic. The use of the related equipment requires specific training. Maintenance also requires the type of training not readily available in field locations. The cost of airborne equipment is high, and equipping an entire region would be very costly. The present expense and complexity of this technology precludes its use on a practical basis by land managers and their professional staffs. However, the next 5 to 10 years may see advances providing a more practical basis for economic application.

Multi-spectral systems using cameras can produce high resolution images on film. The use of the resulting images to create multi-spectral composites for manual or automated interpretation requires very precise and expensive equipment. Image registration is a significant factor in retaining the resolution of very small objects. When false-color composites are created, the products, for many applications, turn out to have been an expensive way to arrive at the equivalent of regular metric aerial photography.

Automated interpretation is a major goal of many remote sensing applications, particularly when large land areas are involved. For many years, whenever a

data volume problem became too large to handle conveniently, one solution was to write a new program and attempt to let a computer manage it. Sophisticated programs backed by reasonably-sized computers can divide images into shades of gray plus levels of color, and by assigning certain gray and color levels to specific land use, the computer can evaluate large land areas and present the information as a land use printout.

However, many users of remote sensing imagery are interested in a level of detail much finer than the relatively gross areas currently within the analysis capabilities of the computer programs. In developing the automated analysis approaches, every effort has been made to remove the human operator or to reduce the system dependence on him because of his limited ability to handle gross quantities of data in a timely fashion. This concept is fully valid in some major programs, but it tends to ignore the analysis activities in which a human operator is far more capable than the computer. These activities cover the observation of minute imagery detail and the analysis of this detail to determine the activity which has been imaged by the collection system. This is true "imagery interpretation" rather than gray and color level detection and recording. There are many imagery analysis problems in which the human "eye-brain-fingertip" combination still performs in the most effective manner. These problem areas include activities wherein the detail may be small, the activities within the area of interest are varied, and the "imagery noise factor" of extraneous information is high.

In summary, as long as the required data for vegetation monitoring consists of targets with diameters appropriately measured in centimeters, sensing systems with resolutions on the order of 15m will remain inadequate. As data are presently collected for determining stocking success in forest plantations, a resolution basement threshold of 40cm is necessary. At present the various electronic aerial remote sensing devices are nearly 40 times too coarse.

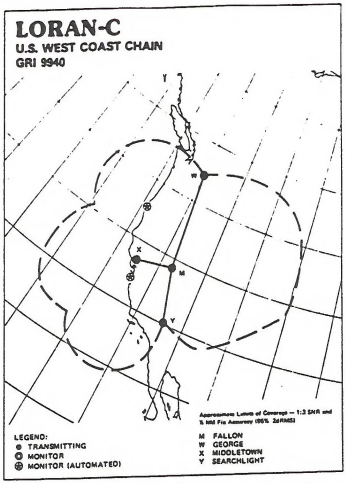
IV. LORAN NAVIGATION METHODS

LORAN-C navigation is a method whereby a point or series of points may be accurately relocated on the ground or from the air without use of visible reference features. Latitude-longitude coordinants are gathered through a system of synchronized radio signal transmissions between a master and two secondary transmitting stations. The state of Oregon falls within the U.S. West Coast Chain coverage zone (Figure 2). The difference in time (TD) -- measured in microseconds (millionths of a second) -- are measured between coded pulses transmitted by the master and secondary stations and used to determine the precise geographic position of the receiver unit.

The LORAN system was used to navigate the aircraft to the forestry plantation test sites. Since in many cases the latilong coordinates provided by the BLM were not in the center of plantation sites, it was necessary for the pilot to visually determine the center of the plantation and change the flight path as needed.

Of the nine plantation sites flown (once in September 1986 and once in February 1987), two were the wrong sites. The A-7 Roseburg pre-establishment site photography covered a plantation site approximately 800 feet to the north of the desired plantation location. The latilong coordinates recorded during the flight were virtually the same as those provided by the BLM, but the sketch map (Appendix E), also provided by the BLM, placed the plantation and coordinate location at the extreme north end of the map. As a result, it was not possible to determine how far to the north the actual plantation site extended. This contributed to the photography missing the desired location. The other "missed" site was the A-3 Coos Bay Backlog site. In this instance, the problem was similar to the other miss, because the plantation and coordinates were placed on the edge of the BLM-provided sketch map.

In general, the 1"=1,000 sectional sketch maps provided by the BLM were not sufficiently adequate to determine where a plantation site was if the LORAN coordinate information was suspect. For future flights, we would suggest providing topo-type maps of an area larger than a section, and also providing, if available, recent small scale aerial photography of the sites. Although the LORAN navigation was sufficient in most cases, supplementing the coordinate locations with better maps and aerial photos would provide excellent back-up information.



U.S. WEST COAST LORAN-C CHAIN - GRI 9940 (old rate 5S6)

STATION	FUNCTION	COORDINATES	CODING DELAY/BASE-LINE LENGTH	RADIATED POWER(kW)	REMARKS
Fallon, NV	Master	39 33 06.6 N 118 49 56.4 W		400	Two pulse comms installed.
George, WA	Whiskey	47 03 48.0 N 119 44 39.5 W	11000/ 2796.90	1600	Two pulse comms installed. Dual-rated to West Coast Canada Chain.
Middletown, CA	Xray	38 46 57.0 N 122 29 44.5 W	27000/ 1094.50	400	Exercises operational control of chain. Control for W, X, and Y. Two pulse comms installed.
Searchlight, NV	Yankee	35 19 18.2 N 114 48 17.4 W	40000/ 1967.30	540	
North Bend, OR	Monsite	43 24 36.2 N 124 14 27.9 W			Unmanned receiver site.
Pt. Pinos, CA	Monsite	36 37 59.0 N 121 56 05.8 W			Unmanned receiver site.

Figure 2. LORAN-C Coverage and Transmitter Stations for the Pacific Northwest.

V. PHOTO INTERPRETATION TEST METHODS

The main objective of this study was to examine the feasibility of using large scale photography to estimate densities of restocked conifers (Douglas fir) and the extent of competing vegetation. All interpretation was conducted on the 2/24/87 color infrared photography.

The interpretation process is quite straightforward (i.e., were the Douglas fir seedling/saplings visible on the aerial photography, and could they be counted?) Competing vegetation (broadleaf trees and shrubs) and shadows both restrict the interpretation/tree counts. Also, larger (older) conifers were obviously easier to count than smaller (younger) conifers. Instructions were provided to each interpreter prior to conducting the test. They are shown on the following two pages. A completed sample tally sheet for Coos Bay, Pre-establishment, A-1, and Plantation Test Site follows the instructions.

EXHIBIT

INSTRUCTIONS

BLM (OREGON) PHOTOINTERPRETATION STUDY - FOREST

Your photo interpretation packet includes the following items:

- 9X9-inch aerial photographs (stereo pairs or triplicates) arranged in the order they should be interpreted.

  Each forest plantation overlay transparency will indicate the number and location of the 20 1/10-acre (approx.) plots randomly assigned to each plantation. Each plot center is indicated by a black (inked) dot. The plot number is located above the center a short distance with a red arrow pointing from it toward the center.

  Where plot centers are easily confused with stumps, they will be circumscribed with a circle somewhat larger than 1/10-acre in size to be used as a location guide.

- A pad of tally forms arranged in the order they are to be used.

- Two 1/10-acre circular plot templates (one extra for safety's sake).

- One "completed" envelope into which each photo set and its related (completed) tally form is to be placed. Do not look at the photographs or tally forms once they are completed.

- One self-addressed return envelope.

Necessary photointerpretation equipment:

- Ideal - an Old Delft stereoscope. Use the 4X setting for actual tree counts. Backlighting the prints on a light table while interpreting is helpful.

- Acceptable - A good quality mirror stereoscope with (at least) a 3X pair of binoculars. Again, backlighting the prints will help.

- Marginal - A pocket stereoscope - most of which have only a 2 - 2½X magnification capability. A 4X pocket stereoscope would be much better. Backlighting would be of questionable value.

Photointerpretation procedure:

1. Remove first set of photos and the top tally sheet from packet.

2. Enter your name and the date.

3. Set up photos for comfortable stereo viewing.

4. Stereoscopically study the examples of conifer reproduction and woody competing vegetation provided on the photos.

5. Locate Plot No. 1 on the photo set; place plot template over photo center. Plot center is a pinprick through overlay and photo. It is surrounded by a large (over 1/10-acre) "finder" circle.

6. To the best of your ability, classify the competitive vegetation (if any) on the plot as to its relative coverage and relative stature.

7. Note that the plot template is divided into quarters to facilitate tree counts.

8. Count conifer seedlings/saplings which appear on the plot. Do your best to exclude competing vegetation from your counts.

9. Enter the count on your form.

10. Make any notes you deem appropriate.

11. Proceed to next plot; repeat procedure for all 20 plots.

12. Put the time used for interpretation in the space provided (hours and fractions thereof).

13. Make any additional comments on the back of the form.

14. Put photo sets and completed tally forms in "completed" envelope.

15. Put "completed" packet in self-addressed envelope and mail.

B

ECON INC.
130 Neill Avenue
Helena, Montana 59601

BLM PHOTOINTERPRETATION STUDY FOREST DATA
TALLY FORM

Plantation, Type COOS BAY (3YEAR) PRE-ESTABLISHMENT
Photo Type, No., Date COLOR INFRARED, A-1-2, FEB. 1987
Average Photo Scale 1:2,873
Average Plot Size 1 ACRE
Interpreter RVAN
Date of Interpretation 6/10/87

PLOT NO.	*COMPETING VEGETATION Coverage (Circle 1 of these)	Stature (Circle 1 of these)	NO. OF TREES PER PLOT	NOTES:
1	L M H	G T		100% SHADOW
2	(L) M H	(G) T	38	
3	L M (H)	G (T)	27	50% SHADOW
4	L M (H)	G (T)	25	40% " "
5	L (M) H	(G) T	9	
6	L (M) H	(G) T	13	
7	L M (H)	G (T)	10	
8	L M (H)	G (T)	55	
9	L (M) H	(G) T	18	
10	L M (H)	(G) T	13	
11	(L) M H	(G) T	16	
12	L M (H)	G (T)	10	
13	L (M) H	(G) T	16	
14	L (M) H	(G) T	11	
15	(L) M H	(G) T	26	
16	L (M) H	G (T)	5	OBVIOUS COMPETING VEGETATION
17	L M (H)	G (T)	11	
18	L (M) H	(G) T	12	
19	L M (H)	(G) T	19	
20	L M (H)	G (T)	31	PARTIAL SHADOWS

* L (Light), M (Medium), H (Heavy)
G (Ground Level), T (Taller)

Time required to accomplish 49 MIN. (Hours)

Figure 3. Sample of Photo Interpretation Form Used to Record Competing Vegetation Characteristics and Stocking Densities.

VI. PHOTO INTERPRETATION RESULTS

A. SUMMER VERSUS WINTER PHOTOGRAPHY

The major difference between the two seasons of photography is the presence/absence of deciduous plant foliage (see Appendix E and photo examples following interpretation summary sheets). By itself, the presence of medium-to-tall broadleaf species precludes the feasibility of using summer photography to accurately count restocked conifers. Only on the youngest plantations — where recolonization or resprouting by competing broadleaves has yet to reach 3-foot heights or more -- or on plantations with steep southwest slopes, is interpretation possible from summer photography.

The primary limitation of winter (leaf-off) photography is the presence of shadows on north or east aspects. Any topographic anomaly is exaggerated at low sun angles. Winter photography, however, is far superior to summer photography in respect to resolving and counting individual conifer trees.

B. COMPETING VEGETATION

The major broadleaf species occurring within the field-checked plantations are shown in Table 1. They are further classified according to stature and morphological characteristics (leaf persistence).

Of most concern are those evergreens which can be confused with the restocked conifers during the winter photo period. Species such as Oregon grape, salal and snowbrush are low-to-medium-stature plants which, set apart by themselves, approximate the growth form and signature characteristics of young conifers.

One phase of the interpretation test involved a general estimate of competing vegetation abundance and stature within the 0.1-acre sample plots. For each sample plot, the interpreter was asked to classify the competing vegetation by light, moderate, or heavy coverage levels. Of the visible competing vegetation, an estimate of stature -- ground (<3' tall) or tall (>3'tall) — also was made.

The results of this portion of the test are inconclusive, as individual interpreter results varied significantly. It should be mentioned that this attribute is very difficult to measure, given the leaf-off condition during the time of photography. The potential does exist for a fairly accurate assessment of competing vegetation if the interpreter expends the necessary time ground-truthing and familiarizing his/herself with the principal signature characteristics.

C. STOCKING DENSITY ESTIMATES

As with most investigations of plant communities, emphasis has been on collecting quantitative data from as many biotic and abiotic attributes as time and funding would permit. These data are typically combined to make general and qualitative statements on the structures of target communities.

Our primary reason for selecting the film type, scale, and time of photography was aimed at securing a photo product which allows an individual to identify and count conifer seedling/saplings with an acceptable degree of accuracy.

The interpretation summary sheets following this section reveal a fair amount of consistency between interpreters. Stocking rates ranged between 100 trees/acre to 300 trees/acre for the nine sites examined.

Our stocking rate estimates are consistently lower than the rates provided to us by the BLM in their regeneration stocking surveys. On the average, our estimates are approximately 100 trees/acre lower than the field surveys show. Of the eight sets of regeneration data provided to us, six of the sites had density estimates greater than 300 trees/acre. We surmise that the differences in methods used to derive stocking estimates may account for the discrepancy in results.

D. TRUE COLOR VERSUS COLOR INFRARED PHOTOGRAPHY

In most cases, color infrared photography was superior to true color photography in determining conifer densities. The added spectrum of color signatures characteristic of color infrared photography enabled most photo interpreters to distinguish the conifers from competing vegetation.

Initially, it was thought the color photography would be better to use because this imagery is not usually as susceptible to shadow obstructions. However, this was not the case, as the shadowing on the color photography also eliminated successful interpretation in most of these areas.

E. AN ASSESSMENT OF PRODUCTIVE VERSUS NONPRODUCTIVE AREAS

During the interpretation process, each plantation was examined for the occurrence of land which due to soil conditions, slope or other abiotic condition was not conducive to the establishment and survival of restocked conifers. Except for some very small patches (<100 $ft.^2$), there were no areas on any of the examined plantations which contained nonproductive land.

F. ADEQUATE VERSUS INADEQUATE STOCKED AREAS

The amount and location of adequate (>150 trees/acre) and inadequate (<150 trees/acre) stocked areas were mapped for each plantation site. Overlays exhibiting this mapping effort are attached to the winter CIR prints (Appendix E) and are included as sketch maps in Appendix H. We were not able to derive acreages of stocked versus nonstocked areas due to the occurrence of shadows on the photography.

TABLE 1

PRINCIPAL BROADLEAF SPECIES-COMPETING VEGETATION-
OBSERVED WITHIN RESTOCKED PLANTATION SITES

	Scientific Name	Common Name	Statue	Foilage
Trees & Shrubs:	Acer circinatum	Vine Maple	M[1]	D[2]
	Acer macrophyllum	Big leaf maple	T	D
	Alnus rubra	Red alder	T	D
	Arbutus menziesii	Madrone	T	E
	Berberis nervosa	Dwarf Oregon grape	G	E
	Castanopsis chrysophylla	Chinquapin	T	E
	Ceanothus species	Snowbrush	M	E
	Corylus cornuta	California hazel	M	D
	Gaultheria shallon	Salal	G	E
	Holodiscus discolor	Oceanspray	M	D
	Lonicera hispidula	Hairy honeysuckle	M	D
	Ribes species	Currant species	G	D
	Rhus diversiloba	Poison oak	M	D
	Rubus parviflorus	Thimbleberry	G	D
	Rubus spectabilis	Salmonberry	G	D
	Rubus ursinus	Trailing blackberry	G	D
	Symphoricarpos mollis	Snowberry (trailing)	G	D
Herbs:	Polystichum munitum	Swordfern	G	E
	Pteridium aquilinum	Bracken fern	G	D

[1] G=0-3 Ft
M=3-10 Ft
T=10 Ft +

[2] D=Deciduous
E=Evergreen

SUMMARY OF INTERPRETATION RESULTS BY PLANTATION SITE
FOR THE COLOR INFRARED AND TRUE COLOR PHOTOGRAPHY

SITE: COOS BAY A-1 PRE-ESTABLISHMENT

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E	
	*[5] 1	-[4]	0[3]	-	0	-	0	-	0	-	-
	2	LG[2]	48	LG	38	LG	45	LG	18	MG	51
	* 3	MG	10	HT	27	MG	21	LG	8	-	-
	* 4	MG	20	HT	25	HG	13	LT	9	-	-
	5	LG	9	MG	9	MG	10	LG	13	MT	2
	6	LG	7	MG	13	MG	15	LG	11	MG	12
	7	LG	13	HT	10	LG	10	MT	15	LG	13
	* 8	MG	45	HT	55	HG	44	HG	8	-	-
	9	LG	21	MG	18	LG	18	LG	10	MG	9
	* 10	LG	17	HG	13	MG	14	LG	13	MT	13
	11	LG	21	LG	16	LG	24	LG	15	-	30
	12	LG	10	HT	10	MG	14	MG	13	LG	12
	13	LG	19	MG	16	LG	20	LG	18	LG	21
	14	LG	16	MG	11	MG	17	LG	15	LG	22
	15	LG	22	LG	28	LG	27	LG	22	MG	22
	16	LG	6	MT	5	HG	15	LG	10	LG	14
	17	LG	23	HT	11	HG	15	MT	15	HT	16
	18	LG	19	MG	12	MG	17	LG	12	-	14
	19	LG	28	MG	19	LG	27	LG	18	-	32
	* 20	MG	27	HT	31	HG	22	MG	14	-	-
Totals		380[6] 19.0[7] 18.6		365 18.2 15.3		388 19.4 18.1		257 13.5 14.6		283 18.9 17.9	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: COOS BAY A-2 ESTABLISHMENT

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

		Interpreter Results A[1]		B		C		D		E	
Plots	1	LG[2]	18[3]	HT	4	MG	14	MG	20	-	-
	2	LG	34	LG	23	LG	33	LG	16	LG	28
	3	-	30	LG	10	MG	26	LG	18	LG	29
	4	LG	25	MG	24	LG	30	LG	21	LG	30
*	5	MG	2	-	0	-	0	-	0	-	-
*	6	MG	22	HT	15	HG	13	MT	14	-	-
*	7	HT	19	HT	7	-	8	MT	12	-	-
*	8	MT	12	HT	4	-	9	LT	8	-	-
*	9	MG	14	HT	11	-	0	MT	6	-	-
*	10	MG	16	HT	20	-	0	-	3	-	-
*	11	-	3	HT	0	HT	3	MT	5	-	-
*	12	MG	18	HT	11	-	0	LT	9	-	-
	13	LG	17	LG	18	MG	18	LG	14	LG	22
	14	LG	49	LG	36	MG	51	LG	28	LG	52
*	15	-	0	-	0	-	0	-	0	-	-
*	16	MG	4	-	0	-	0	-	2	-	-
*	17	MT	21	HT	11	-	0	LT	7	-	-
	18	MG	40	MG	25	HG	16	LT	21	HT	18
	19	LG	14	MG	8	HG	11	LG	8	LG	6
	20	-	15	LG	11	LG	9	LG	7	LG	21
Totals		369[4]		238		239		215		208	
		18.4[5]		11.8		11.9		11.9		25.8	
		26.7[7]		17.4		22.9		16.8		22.9	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: COOS BAY A-3 BACKLOG

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		Interpreter Results 8		Interpreter Results C		Interpreter Results D	
	1	LG[2]	12[3]	LG	8	LG	15	LG	16
	2	LG	29	LG	16	LG	24	LG	19
*[4]	3	HT	5	HT	7	HT	6	MG	9
	4	MG	20	HT	23	HT	13	LT	24
	5	LG	8	MT	7	MG	8	LG	23
	6	LG	14	LG	12	LG	8	LG	14
	7	LG	5	MT	5	MG	7	MT	8
	8	LG	6	MG	18	MG	25	LG	24
	9	LG	13	LG	8	LG	12	LG	16
	10	LG	3	LT	4	LG	5	LG	15
	11	LG	2	LG	2	LG	2	LG	6
	12	MT	4	HT	9	HT	12	MT	13
*	13	HT	10	HT	4	HT	4	MT	13
	14	LG	9	LG	12	LG	13	LG	13
	15	MT	1	HT	7	HT	1	MT	11
*	16	MT	13	HT	15	HT	8	LG	9
*	17	MT	41	HT	33	MG	31	LG	25
*	18	HT	8	HT	16	HT	13	MG	19
	19	LG	27	MG	30	MG	14	LG	27
	20	LG	34	MG	28	MG	27	LG	26
Totals		264[5]		262		248		330	
		13.2[6]		13.1		12.4		16.5	
		12.5		12.5		12.4		17.0	

[1] A,8,C, and D = ECON Interpreters.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] * = Shadowed plot - total tree count not possible.

[5] Average density per 1/10-acre sample plot.

[6] Average density for non-shadowed plots only.

SITE: EUGENE A-4 PRE-ESTABLISHMENT

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

Plots	Interpreter Results A[1]		B		C		D		E	
		[3]								
1	MT[2]	13	HG	12	HG	14	MG	8	HG	25
2	LG	24	MG	28	HG	21	MG	11	MG	62
3	LG	7	HG	8	MG	4	LG	2	MG	33
4	LG	15	MG	18	MG	9	MG	14	MG	57
5	LG	21	MG	10	MG	9	LG	4	MG	29
6	LG	4	MG	15	MG	8	MG	6	MG	46
7	LG	20	HG	22	MG	19	LG	11	MG	48
8	LG	15	HG	22	MG	18	MG	11	LG	40
9	LG	15	MG	39	LG	24	MG	8	MG	40
10	LG	24	HG	31	LG	38	LG	10	MG	48
11	LG	16	HG	13	HG	15	MG	15	HG	45
12	LG	10	MG	19	LG	6	LG	0	MG	38
13	LG	5	-[4]	12	HG	5	MT	0	MG	30
14	LG	15	MG	34	MG	11	LG	5	MG	36
15	LG	43	HT	15	HG	18	MG	12	HG	48
16	LG	27	MG	15	LG	17	LG	11	MG	48
17	LG	27	HG	50	HG	21	MG	10	MG	45
18	LG	12	MG	25	MG	9	LG	5	MG	42
19	LG	27	MG	36	HG	18	MG	14	HG	45
20	LG	16	MT	48	MG	23	LG	18	MG	33
Totals	356[5]		472		307		175		838	
	17.8		23.6		15.3		8.7		41.9	

[1] A,B,C and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M= Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] Average density per 1/10-acre sample plot.

SITE: EUGENE A-5 ESTABLISHMENT

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

Plots			Interpreter Results A[1]		B		C		D		E	
	*[4]	1	MT[2]	23[3]	HT	22	HG	22	MT	10	HT	22
		2	LG	20	HT	20	MT	18	MT	4	HT	21
	*	3	MG	53	HT	33	HG	32	HG	24	MT	33
	*	4	MG	36	HT	33	MG	26	HG	19	MT	36
		5	LG	23	MT	16	HG	28	LT	4	HT	17
		6	LG	27	MG	26	MT	32	LG	13	MT	50
		7	LG	23	MG	9	MG	29	MT	9	HT	21
		8	LG	52	MG	44	HG	54	LG	37	LT	38
		9	LG	40	HG	24	HG	31	MG	26	MT	32
	*	10	MG	24	HT	19	MG	19	MG	17	MT	33
		11	LG	20	MG	9	HG	15	HG	5	MT	23
	*	12	MT	17	HT	11	HT	11	MT	3	MT	11
		13	LG	37	LG	30	MG	43	MG	25	MT	45
	*	14	MG	38	HT	35	HG	40	MG	19	MT	42
	*	15	MT	15	HT	10	HG	18	MT	7	HT	20
		16	LG	12	MT	6	HT	10	MT	3	HT	9
		17	MT	42	HT	33	HT	42	MG	16	MT	34
		18	LG	38	MG	24	HG	43	MT	5	MT	40
		19	LG	16	MG	12	MG	19	LG	11	LT	22
		20	LG	39	HT	21	HG	43	LT	15	HT	26
Totals			595[5]		437		573		272		575	
			29.7[6]		21.8		28.6		13.6		28.7	
			29.9		19.6		31.2		13.3		29.1	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (> 3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] * = Shadowed plot - total tree count not possible.

[5] Average density per 1/10-acre sample plot.

[6] Average density for non-shadowed plots only.

SITE: EUGENE A-6 BACKLOG

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E	
	1	HG[2]	4[3]	HG	4	HG	12	HG	1	MT	40
	2	MG	19	HG	10	HG	20	HG	3	HT	20
*[5]	3	MG	11	HT	9	HG	12	MT	4	MT	15
	4	MT	26	HT	3	HG	17	HT	4	HT	35
*	5	HT	14	HT	7	HG	17	HT	8	HT	24
	6	MG	50	MT	32	HG	34	MG	18	MT	30
*	7	HT	27	HT	12	HG	18	MG	10	MT	30
*	8	MT	50	HT	18	HG	14	HT	6	MT	26
*	9	HT	15	HT	4	-	0	HT	5	MT	31
*	10	HT	22	HT	2	HG	13	HT	1	MT	17
	11	MT	74	HT	25	HG	37	HT	9	MT	38
	12	MT	27	HT	18	HG	17	HT	6	MT	27
	13	MG	84	HT	48	HG	60	MG	31	MT	43
	14	MT	92	HT	27	HG	36	MG	21	MT	32
	15	MG	33	HT	27	HG	28	HG	9	MT	40
	16	MT	75	HT	5	HG	12	HT	0	HT	16
	17	MT	72	HT	17	HG	19	HT	13	HT	12
	18	MG	47	HT	27	HG	16	HG	6	MT	32
	19	MG	44	HT	28	HG	23	MG	14	MT	37
*	20	MG	16	HT	14	-	10	-	0	MT	26
Totals		802[6]		335		415		165		571	
		40.1		16.7		20.7		8.6		28.5	
		49.8[7]		20.7		25.5		10.2		30.9	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: ROSEBURG A-7 PRE-ESTABLISHMENT

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

Plots	Interpreter Results A[1]		B		C		D		E	
		[2] [3]								
1	LG	0	LG	0	LG	2	MG	0	HG	0
2	LG	2	LG	6	MG	13	MG	9	HG	0
3	LG	8	LG	0	MG	7	MG	0	HG	2
4	LG	3	LG	1	MG	2	MG	2	HG	0
5	LG	0	LG	0	LG	3	HG	0	HG	0
6	LG	5	LG	0	MT	7	MT	1	HG	2
7	LG	4	LG	5	MG	6	MG	3	HG	3
8	LG	6	LG	10	MG	11	MG	0	HG	0
9	LG	11	LG	3	MG	10	MG	8	HG	6
10	LG	0	MG	0	MG	0	MG	0	HG	0
* 11	LG	5	LG	0	MG	3	MG	4	MT	0
12	LG	0	LG	3	HG	1	MG	1	HG[4]	0
13	LG	1	MG	3	MG	4	MG	3	-	0
* 14	LG	4	LT	3	MG	10	HG	6	HG	0
15	LG	0	LT	1	MT	2	MG	3	HG	0
16	LG	15	LG	8	LG	11	MG	8	HG	7
17	LG	12	LG	6	MG	19	HG	4	HG	7
18	LG	4	LG	1	HG	7	HG	11	MT	0
* 19	LG	0	LG	3	HG	1	MG	0	HG	0
20	LG	0	LG	3	LG	3	MG	8	HG	0
Totals		80[6]		56		122		71		27
		4.0		2.8		6.1		3.5		1.3
		4.2[7]		2.9		6.4		3.6		1.6

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: ROSEBURG A-8 ESTABLISHMENT

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E	
	*[5] 1	MT[2]	43[3]	HT	7	MG	33	MT	16	-	0
	2	LG	10	MT	1	LG	7	MT	2	HT	6
	3	LG	13	MT	5	LG	11	MG	8	HT	5
	* 4	-	-[4]	-	-	HT	2	-	0	-	0
	5	LG	16	HT	4	MG	17	MT	11	-	6
	6	MT	19	MT	11	MG	13	MT	4	LG	5
	* 7	MT	31	HT	3	MT	20	MT	16	-	0
	8	LT	24	MT	7	MG	17	MT	9	MG	7
	* 9	LG	10	-	0	LT	12	MT	4	-	6
	10	LG	22	MT	9	MG	16	MT	10	MT	4
	* 11	MT	4	HT	0	MT	2	-	0	-	0
	12	LG	17	MT	11	LG	14	LG	8	-	4
	* 13	LG	29	HT	0	MG	23	-	19	-	15
	14	MT	3	HT	0	MT	2	MT	1	HT	2
	15	LG	21	MT	11	LG	19	MG	11	-	15
	* 16	LG	18	HT	0	LG	15	MT	0	-	-
	* 17	-	2	-	0	-	1	-	0	-	0
	18	LG	5	LG	0	LG	3	LG	2	HG	3
	19	LG	23	MT	5	LG	18	LG	12	-	-
	20	LG	18	LG	8	LG	12	MG	10	HT	7
Totals		324[6]		82		257		141		85	
		17.0[6]		4.8		12.8		8.2		5.6	
		15.8[7]		6.0		12.4		7.2		5.3	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: ROSEBURG A-9 BACKLOG

FILM TYPE: COLOR INFRARED

Degree of Competing Vegetation and Conifer Density

		Interpreter Results									
		A[1]		B		C		D		E	
Plots	*[5] 1	-[4]	12[3]	MT	7	LG	8	LG	0	-	5
	2	LG[2]	17	LG	10	LG	14	LG	9	-	10
	3	LG	9	MG	8	LG	10	LG	8	-	3
	4	LG	12	LG	8	LG	13	LG	7	-	2
	5	LG	9	LG	8	LG	8	LG	4	-	5
	6	LG	7	LG	3	LG	8	LT	3	-	3
	* 7	LG	9	LG	6	LG	6	LG	5	-	4
	8	LG	38	LG	13	LG	17	LG	28	-	15
	9	LG	32	LG	21	LG	18	LG	16	-	12
	* 10	LG	8	MG	5	LG	7	LG	4	-	4
	* 11	HT	9	HT	6	LG	9	LG	5	-	0
	12	LG	12	MG	10	LG	7	LG	9	-	0
	13	LG	6	LG	3	LG	8	LG	4	-	0
	* 14	LG	13	LG	5	LG	11	LG	5	-	14
	15	LG	14	MG	9	LG	13	LG	8	-	0
	16	LG	11	MG	10	LG	12	LG	4	-	7
	17	LG	5	LG	4	LG	5	LG	3	-	4
	18	LG	7	LG	2	LG	7	LG	4	-	3
	19	-	12	LG	1	LG	2	LG	3	-	0
	* 20	-	13	LG	9	LG	11	LG	-	-	0
Totals		255[6]		148		188		129		91	
		12.77		7.4		9.4		6.7		6.5	
		13.6[7]		7.9		9.7		7.9		4.8	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: COOS BAY A-1 PRE-ESTABLISHMENT

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E	
	*[5] 1	-	-[4]	-	-	-	-	-	-	-	-
	2	LG[2]	37[3]	LG	21	LG	24	MG	15	MG	7
	* 3	-	17	MT	5	HG	9	HG	5	-	-
	* 4	-	16	HT	12	HG	10	HG	8	-	-
	5	LG	20	MG	15	HG	13	MG	12	-	6
	6	LG	7	LG	16	HG	12	LG	12	LG	19
	7	LG	10	LG	13	HG	10	MG	7	MT	12
	* 8	MG	10	HT	14	HG	11	-	1	-	-
	9	LG	15	LG	15	HG	9	MG	14	-	4
	* 10	LG	18	LG	12	HG	12	MG	14	-	6
	11	LG	20	LG	23	LG	21	MG	17	LG	33
	12	LG	7	MG	5	HG	3	HG	3	MT	8
	13	LG	28	LG	24	MG	23	MG	21	LG	21
	14	LG	13	LG	19	MG	18	MG	15	LG	22
	15	LG	34	LG	24	LG	33	-	-	MG	17
	16	-	25	LG	14	MG	18	MG	9	LG	12
	17	LG	8	MT	10	HG	6	MT	12	HT	5
	18	LG	20	LG	14	MG	19	MG	14	LG	22
	19	LG	46	LG	43	LG	31	MG	23	LG	36
	* 20	MT	20	HT	19	HG	20	MG	15	-	-
Totals			371[6]		318		302		215		230
			19.5		16.7		15.9		11.9		15.3
			20.7[7]		18.3		17.1		12.4		16.0

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: COOS BAY A-2 ESTABLISHMENT

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E	
		[2]	[3]								
	1	HT	3	MG	4	HG	5	HT	0	HT	0
	2	LG	18	LG	15	MG	9	MG	12	LG	15
	3	LG	30	LG	25	MG	22	MG	21	LG	27
[5]	4	LG[4]	27	LG	18	MG	13	MG	13	MG	22
*	5	-	-	-	-	-	-	-	0	-	-
*	6	HT	30	HT	10	HT	12	HT	2	-	-
*	7	HT	15	HT	6	HT	10	HT	3	-	-
*	8	HT	2	-	-	-	-	HT	2	-	-
*	9	-	-	-	-	-	-	-	0	-	-
*	10	HT	41	HG	21	HG	16	HT	8	-	-
*	11	HT	4	MT	2	HT	2	MT	3	-	-
*	12	MG	20	-	-	HG	8	HT	3	-	-
	13	LG	17	LG	14	MG	16	LG	11	LG	20
	14	LG	38	LG	8	HG	8	MG	11	-	8
*	15	HT	2	-	-	-	-	-	0	-	-
*	16	-	-	-	-	-	-	-	0	-	-
*	17	HT	45	HT	11	-	10	HT	4	-	-
	18	HT	13	MG	17	MG	18	MG	14	LG	17
	19	LG	12	LG	1	MG	5	MG	6	MG	9
	20	LG	10	LG	10	LG	9	MG	11	LG	14
Totals		327[6]		162		181		122		132	
		19.2[7]		11.5		10.7		7.8		14.7	
		18.6		12.4		11.4		11.0		14.7	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: COOS BAY A-3 BACKLOG

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]	B	C	D
	1	LG[2] 6[3]	LG 5	MG 5	MG 14
[4]	2	LG 26	LG 16	MG 16	MG 24
*	3	MT 0	HT 4	HT 4	MT 1
	4	MT 11	HT 3	HT 6	MT 4
	5	MG 6	MG 5	HG 4	HG 16
	6	LG 14	LG 7	MG 6	MG 17
	7	MT 8	MG 2	HG 10	MG 13
	8	LG 4	MG 1	MG 3	MG 11
	9	LG 10	LG 8	MG 5	MG 7
	10	LG 3	LG 0	LG 1	MG 7
	11	LG 2	LG 0	MG 1	MG 2
	12	MT 0	HT 1	HT 4	HT 0
*	13	MT 8	HT 0	HT 4	HT 0
	14	LG 8	LG 4	MG 9	MG 18
	15	MT 5	HT 3	HT 2	MT 7
*	16	MT 0	HT 0	HT 3	MT 0
*	17	MT 1	HT 3	HG 6	MT 3
*	18	MT 7	HT 3	HT 5	MT 1
	19	MG 21	MG 3	HG 6	MG 8
	20	MG 16	MG 8	HG 14	MT 10
Totals		156[5]	76	114	161
		7.8[5]	3.8	5.7	8.0
		9.3[6]	4.4	6.1	10.4

[1] A,B,C, and D = ECON Interpreters.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] * = Shadowed plot - total tree count not possible.

[5] Average density per 1/10-acre sample plot.

[6] Average density for non-shadowed plots only.

SITE: EUGENE A-4 PRE-ESTABLISHMENT

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots	Interpreter Results A[1]	B	C	D	E
1	MG[2] 24[3]	MT 12	HG 17	MG 20	HG 24
2	LG 30	LG 35	HG 20	LG 36	HG 60
3	LG 10	LG 5	MG 8	MG 7	MG 38
4	LG 16	LG 9	MG 15	MG 23	MG 61
5	LG 27	LG 6	HG 10	MG 19	MG 33
6	LG 17	LG 6	MG 6	MG 25	MG 48
7	LG 7	LG 8	MG 8	LG 22	MG 51
8	LG 32	LG 10	MG 19	MG 21	MG 41
9	LG 18	LG 5	MG 10	MG 20	MG 44
10	LG 41	MG 24	HG 19	MG 15	MG 51
11	LG 10	MG 11	MG 8	LG 25	HG 47
12	LG 10	LG 1	LG 6	MG 11	MG 37
13	LG 9	MG 4	HG 3	LG 11	MG 30
14	LG 9	LG 4	MG 5	MG 18	MG 40
15	MG 30	MG 14	MG 14	MG 14	HG 47
16	LG 12	LG 13	LG 8	MG 19	MG 53
17	LG 23	LG 26	MG 21	MG 16	MG 50
18	LG 19	MG 5	MG 8	MG 19	MG 47
19	LG 21	LG 3	MG 15	LG 27	HG 40
20	LG 49	MG 20	HG 23	MG 26	MG 35
Totals	414[4] 20.7	221 11.0	241 12.0	394 19.7	873 43.6

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] Average density per 1/10-acre sample plot.

SITE: EUGENE A-5 ESTABLISHMENT

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

		Interpreter Results[1]							
		A		B		C		D		E	
Plots	*[5] 1	HT[2]	28[3]	MT	5	HT	16	MT	12	HT	24
	2	MT	12	MT	5	MT	7	MT	7	HT	20
	* 3	MG	55	MT	25	HT	37	MT	24	MT	30
	* 4	MG	12	HT	6	HT	15	MT	5	MT	35
	5	LG	17	MT	5	MG	15	MG	13	MT	20
	6	LG	28	MG	21	MG	16	MG	21	MT	46
	7	MG	26	HT	6	MG	19	MG	8	HT	20
	8	LG	60	LG	43	MG	42	MG	39	LT	43
	9	LG	34	LG	28	MG	22	MG	22	MT	35
	* 10	HT	24	MT	12	HT	15	HG	9	MT	35
	11	LG	23	LT	10	HG	14	MG	11	MT	25
	* 12	MT	9	MT	3	HT	8	MT	8	MT[4]	15
	13	LG	41	LG	26	MG	26	MG	21	-	40
	* 14	HT	34	MT	28	HG	31	MG	20	MT	36
	* 15	MG	13	MT	3	HG	12	MT	8	-	22
	16	MG	9	MT	3	HG	8	MT	5	HT	10
	17	MT	22	MT	10	MG	20	MT	18	MT	35
	18	LG	42	LG	25	MG	23	MG	23	MT	38
	19	LG	13	LG	14	MG	16	LG	8	LT	25
	20	MG	23	MT	9	MG	7	HG	14	MT	29
Total		523[6]		287		369		294		583	
		26.1[7]		14.3		18.4		14.7		29.1	
		25.9		13.6		18.0		16.1		29.6	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: EUGENE A-6 BACKLOG

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E	
	1	MG[2]	8[3]	MG	2	HG	7	HT	0	MT	43
	2	MG	15	NG	11	HG	8	MT	12	HT	25
*	3[5]	HT	5	HT	2	HG	3	HT	0	MT	17
	4	MT	23	MG	16	HG	6	HT	8	HT	30
*	5	HT	13	HG	6	HT	10	HT	5	MT	25
	6	LG	24	MG	20	HG	10	MT	9	MT	28
*	7	HT	33	HT	22	MG	13	HT	20	MT	31
*	8	MT	11	HT	3	HT	8	HT	7	MT	23
*	9	HT	13	HT	7	HT	8	HT	9	MT	27
*	10	MT	4	MT	3	HG	6	HT	2	MT	20
	11	HT	32	HG	11	HT	19	HT	12	MT	36
	12	MT	19	MG	6	HG	10	HT	3	MT	26
	13	MG	61	HT	15	HG	20	MT	27	MT[4]	44
	14	HT	34	MT	6	HG	17	MT	13	-	29
	15	MG	25	MT	23	HG	13	HT	13	MT	37
	16	MT	48	HT	0	HT	6	HT	3	HT	16
	17	MG	37	MG	3	HG	9	HT	3	HT	17
	18	MG	20	MG	13	HG	10	MT	8	MT	35
	19	MG	26	HG	18	HG	14	MT	14	MT	35
*	20	HT	23	HT	23	HG	18	MT	21	MT	24
Totals		474[6]		210		215		189		568	
		23.7[7]		10.5		10.7		9.4		28.4	
		28.6		11.0		11.4		9.6		30.8	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: ROSEBURG A-7 PRE-ESTABLISHMENT

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E	
	1	LG[2]	0[3]	LG	0	MG	2	LG	9	HG	0
	2	LG	3	LG	6	MG	3	LG	9	HG	0
	3	LG	9	LG	0	MG	5	LG	0	HG	0
	4	LG	4	LG	1	LG	2	LG	0	HG	0
	5	LG	0	LG	0	LG	3	LG	2	HG	0[4]
	6	LG	5	LG	0	HG	4	MT	0	HG	-
	7	LG	3	LG	5	LG	2	LG	0	HG	0
	8	LG	14	LG	10	LG	8	LG	6	HG	0
	9	LG	8	LG	3	LG	4	LG	15	HG	0
*[5]	10	LG	2	MG	0	LG	1	LG	2	HG	0
*	11	LG	5	LG	0	LG	2	LG	0	MT	0
	12	LG	0	LG	3	MG	0	LG	14	MG	0
	13	LG	6	MG	3	MG	1	LG	8	HG	0
*	14	LG	3	LT	3	LG	2	LG	0	HG	0
	15	LG	1	LT	1	LG	2	LG	1	HG	0
	16	LG	13	LG	8	LG	6	LG	7	HG	0
	17	LG	9	LG	6	LG	7	LG	25	HG	2
	18	LG	4	LG	1	LG	1	LG	0	HG	0
*	19	LG	0	LG	3	MG	1	MG	0	HG	0
	20	LG	0	LG	3	LG	1	LG	0	HG	0
Totals		89[6]		56		57		98		2	
		4.4[7]		2.8		2.8		4.9		.1	
		4.7		2.9		3.0		5.7		.1	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: ROSEBURG A-8 ESTABLISHMENT

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots	*		Interpreter Results A[1]		B		C		D		E	
		1	HT[2]	5[3]	HT	0	MT	8	HT	0	-	0
		2	LG	7	MT	2	MT	4	MT	1	HT	3
		3	LG	7	LG_4	2	LT	5	LT	6	HT	5
	*	4	MT	0	-	-	HT	1	HT	0	MT	0
		5	LG	24	MT	0	MG	17	LG	8	-	9
		6	MT	4	MT	1	MT	8	LT	4	HT	2
	*	7	HT	4	-	-	HT	3	HT	0	-	0
		8	MG	17	HT	2	LT	12	MT	2	HT	6
	*	9	MT	5	HT	-	LT	3	-	0	HT	2
		10	LG	12	MT	7	MG	13	MT	5	HT	2
	*	11	HT	3	MT	-	HT	2	HT	0	HT	0
		12	LG	13	MT	4	LG	11	LT	7	-	5
	*	13	MG	22	MT	-	LT	12	-	0	-	14
		14	MT	2	MG	0	HT	2	HT	2	HT	2
		15	LG	10	LT	5	MG	8	LG	9	MT	5
	*	16	MT	12	HT	2	MG	10	-	0	-	3
	*	17	HT	2	HT	-	-	-	-	0	-	0
		18	LG	9	LG	3	LG	3	LG	3	-	-
		19	LG	11	MT	0	LG	11	LG	4	-	-
		20	LG	10	LG	3	LG	7	LG	5	HT	4
Totals			179_6		31		140		54		62	
			8.9[7]		1.7		7.3		3.3		4.7	
			10.5[7]		2.4		8.4		4.5		3.5	

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (> 3 ft. tall)

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

[5] * = Shadowed plot - total tree count not possible.

[6] Average density per 1/10-acre sample plot.

[7] Average density for non-shadowed plots only.

SITE: ROSEBURG A-9 BACKLOG

FILM TYPE: COLOR

Degree of Competing Vegetation and Conifer Density

Plots		Interpreter Results A[1]		B		C		D		E
	*[5] 1	LG[2]	10[3]	LG	6	MG	11	MT	8	- 4
	2	LG	14	LG	12	LG	12	LG	11	- 7
	3	LG	13	LG	8	LG	10	LG	7	- 3
	4	LG	12	LG	7	LG	12	LG	11	- 4
	5	LG	7	LG	8	LG	8	LG	7	- 6
	6	LG	7	LG	4	LG	4	LG	3	- 4
	* 7	LG	8	LG	6	LG	8	LG	5	- 3
	8	LG	24	LG	15	LG	17	-	15	- 9
	9	LG	30	LG	18	LG	21	LG	16	- 13
	* 10	MG	9	LG	6	LG	11	LG	6	- 0
	* 11	MT[4]	6	-	3	MT	6	-	3	- 0
	12	-	10	LG	6	LG	11	LG	8	- 0
	13	LG	6	LG	4	LG	4	LG	5	- 0
	* 14	LG	16	LG	8	LG	17	LG	5	- 0
	15	LG	13	LG	8	LG	16	LG	9	- 0
	16	LG	10	MG	5	LG	6	LG	4	- 0
	17	LG	4	LG	4	LG	4	LG	7	- 0
	18	LG	12	LG	5	LG	11	LG	3	- 0
	19	LG	10	LG	3	LG	7	LG	3	- 0
	* 20	LG	12	LG	9	LG	10	-	13	- 0
Totals			231[6]		145		206		149	53
			11.5[7]		7.2		10.3		7.4	5.8
			12.3		7.6		10.2		7.8	3.3

[1] A,B,C, and D = ECON Interpreters; E = BLM Interpreter.

[2] L = Light; M = Moderate; H = Heavy; G = Ground Vegetation (<3 ft. tall); T = Tall Vegetation (>3 ft. tall).

[3] Number of conifer seedlings/saplings counted within 1/10-acre sample plot.

[4] - = Data not recorded by interpreter.

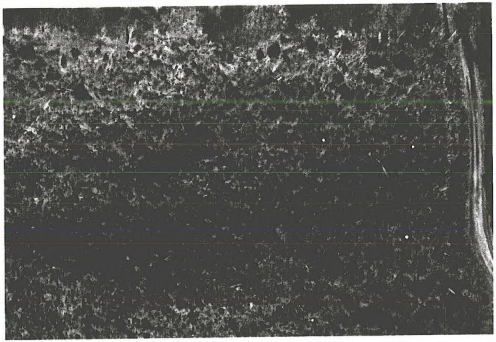
[5] * = Shadowed plot - total tree count not possible.

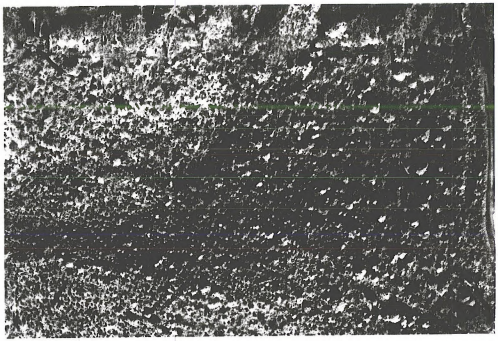
[6] Average density per 1/10-acre sample plot.

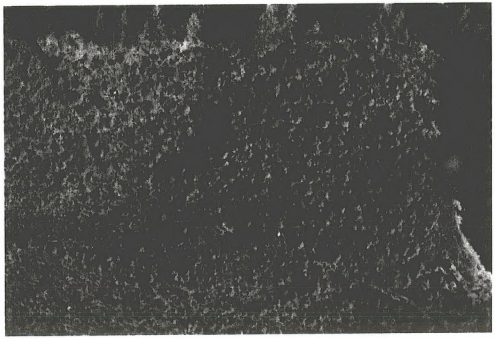
[7] Average density for non-shadowed plots only.

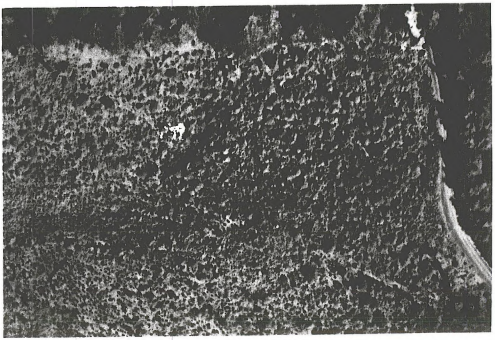
PHOTOS

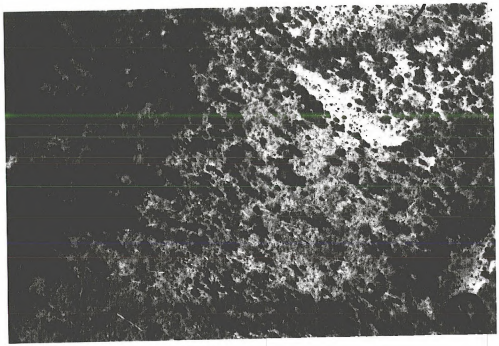
The first two pages contain 35mm print enlargements (1:1,000 scale) taken from the 9x9-inch plantation photos. These photos constitute the difference between CIR and true color photography obtained during summer months (B and D) and winter months (A and C).

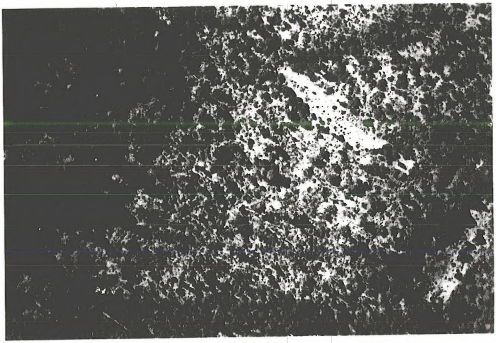


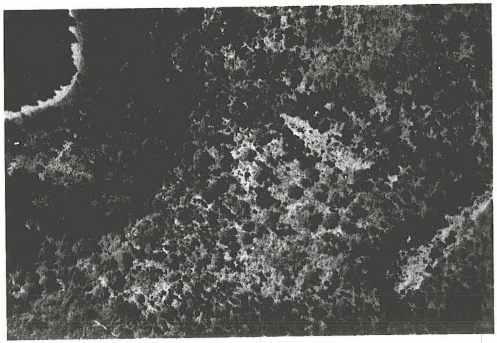


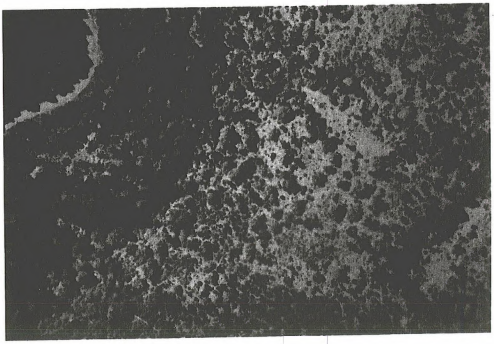








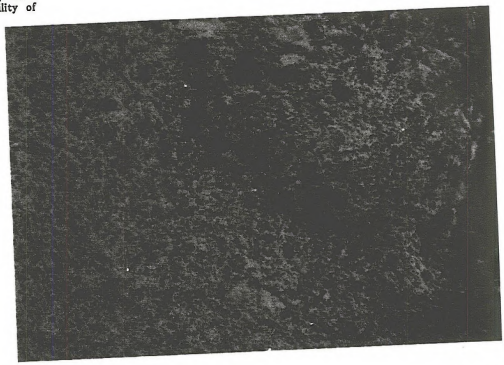


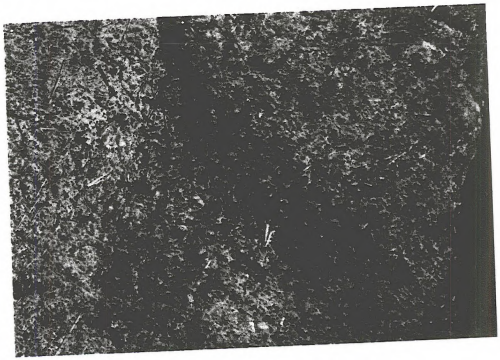


Coos Bay: A-1. Pre-establishment

Top Photo: August 1986 CIR
Bottom Photo: March 1987 CIR

(Notice the absence of ground vegetation in the early spring photo and visibility of seedlings.)

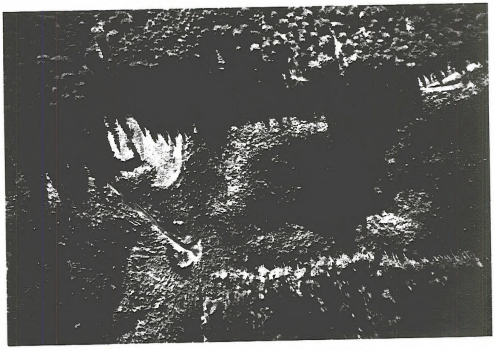




Eugene: A-6. Backlog

Top Photo: August 1986 CIR
Bottom Photo: March 1987 CIR

The effects of shadow are limiting during winter leaf-off periods for plantation sites with steep north and/or east aspects.



VII. SUMMARY

A. SELECTION OF POTENTIAL PLANTATIONS

Examination of the winter photography makes it obvious that not all plantations can qualify for photo interpretation based on the effects steep slopes have on shadowing. Therefore, each plantation must be stratified according to aspect. This step will eliminate a great deal of uncertainty once interpretation commences.

Another important concern involves the amount of exposed bare soil on the site. Because camera exposure/aperture settings are based on an "average" reflectance of the total area, some areas tend to be overexposed, while others underexposed. It is much easier to work with images slightly underexposed as opposed to those slightly overexposed. A tree seedling can easily be "bleached out" by highly reflective bare soil. This circumstance was rarely encountered on the prints, but nevertheless it should be viewed as a potential limitation of the process.

B. IMAGE RESOLUTION

Given the resolution capabilities of 9"x9" photography at a scale of 1:3,000, minimum tree diameter of about two feet is required for accurate resolution. This is not to say that all seedlings two feet or greater in diameter can always be identified on a print. Factors such as shadows, surface reflectance, overstory canopies of competing vegetation, and signature similarities with other plants can alone, or in combination, make it extremely difficult to ascertain total density counts.

C. SAMPLE PLOT DESIGN AND SAMPLE SIZE

Currently the BLM incorporates a sampling system of systematically-placed plots which measure presence-absence of restocked seedlings/saplings. For the most part, stocking density estimates are calculated from the percentage of plots in which a target species occurs. The percentage of "stocked plots" is multiplied by a predetermined constant to derive pounds/acre estimates. For interpretation purposes, ECON employed a sample system of randomly placed 1/10-acre plots. A grid constructed on a clear plastic sheet was overlaid on the center photo of each triplet. Twenty plot locations were selected from a possible 255 grid points. A random numbers table was used to generate numbers which occur within the plantation boundaries. The irregular shapes and sizes of the plantations make it necessary for the grid overlay to cover the entire 9"x9" print.

There are a variety of methods which could be developed for selecting plot locations. Because most parametric statistics require a randomly-selected set of sample points within given populations, it is strongly suggested that the BLM follow the non-bias assumptions of the statistical test(s) with which the data will be treated.

D. PROCEDURAL GUIDELINES FOR FORESTRY MONITORING

1. Establish Study Areas

Areas should be selected to avoid obvious shadow/terrain restrictions.

2. Determine Number of Test Sites per Study Area

a. Statistically, the total number of test sites necessary to provide a valid sample must be determined.

b. Sample adequacy should be based on cumulative sample acreage.

3. Determine Test Site Locations

Locations should be determined randomly.

Random latitude/longitude coordinates can be generated by computer or manually with standard random number tables.

4. Coordinate Test Site Photography Acquisition

a. Requirements:

(1) Bids should be solicited from local flight contractors headquartered within 500 miles of the test sites. Use of local contractors should allow the fast response time necessary to acquire photography within a narrow phenological window.

(2) The Contractor should not be allowed to subcontract any portion of the project.

(3) The Contractor shall not use color infrared film requiring any color correction filtration. Only anti-vignetting and Wratten 12 filters shall be used. The color infrared film shall be handled strictly in adherence to manufacturer's specifications prior to, during, and after the flight.

b. Aerial Photography:

(1) Quality of photography: Photographic products shall be clear and sharp in detail and of average and uniform density, free from clouds and cloud shadow, light streaks, snow, static marks, and other blemishes. They shall be taken at such time as to provide color, yet preclude the formation of a "sunspot" on the photography. Camera installation in the aircraft shall be such that film advance is on the same axis as direction of flight in order to assure proper stereo viewing of uncut film rolls. Only materials meeting stated requirements should be accepted.

(2) Scale variation: The average scale of each photo sequence should show a variation of not more than 5 percent. Larger scale variations may result in the rejection of an entire photo sequence.

(3) Overlap: Endlap shall be 55-65 percent, for an average of 60 percent.

(4) Tilt: Average shall not be in excess of two degrees.

(5) Crab: Average shall not be in excess of four degrees.

(6) Time of photography: The Contractor shall complete the photography within 1 1/2 weeks before or after the date specified; that is, within a 3-week range. In the event that weather appropriate for obtaining color infrared photography does not occur within the specified period, the contracting officer or his authorized representative will notify the Contractor whether an additional range of time for later photography will be acceptable. The photography shall be flown at such times of day as to preclude a "sunspot" in the area of coverage.

(7) Film/film processing: The aerial film to be used shall have a fine-grain emulsion on a dimensionally stable polyester base, known as DuPont "Cronar," Eastman Kodak "Estar," or equal. All aerial film shall be developed within one week of exposure, in strict adherence to the manufacturer's recommendations. A minimum of two sets of prints (gloss cibachrome) should be requested.

c. Cameras:

(1) A single-lens, calibrated, precision-type camera shall be used to expose on a format approximately 9"x9".

(2) The camera shall be equipped with an approved means of flattening the film at the instant of exposure.

(3) The fiducial marks shall be capable of registering clean, smooth marks.

(4) The camera shall be equipped with a between-the-lens shutter of the variable-speed type.

(5) The camera shall be equipped with marks which will record the lens number and calibration focal length of the lens of the camera on each negative. These marks shall not protrude more than 1/4-inch into the format of the camera and shall be set in a corner.

(6) The camera shall be equipped with one of the following lenses:

(a) 8 1/4" (210mm $\pm$ 3mm)
(b) 12" (305mm $\pm$ 4mm)

(7) The above lenses shall have the following characteristics:

(a) Minimum resolving power of 35 lines per millimeter as measured with a high contrast target.
(b) Maximum tangential distortion of 0.015mm.

(c) An anti-vignetting type filter. All filters shall have two surfaces parallel to within 10 seconds of arc. Optical quality shall not cause undesirable reduction in image resolution. (Special care shall be taken to assure that the anti-vignetting pattern will be such that the density will be uniform from the corners through the center of the image.)

5. Photo Interpretation

a. Photography Quality:

(1) Examine photography for compliance with contract specifications.

(2) Check photo center coordinate information for contract compliance.

b. If photography is acceptable, label the photography with appropriate identifier, such as district name, latitude, longitude, etc. An .05mm dimensionally-stable, clear mylar overlay should be attached (taped permanently) to the photo(s) used for photo interpretation.

c. Within the plots selected, delineate on the overlay a minimum sample unit (microplot) of uniform vegetative composition representing approximately 1/10 acre on the ground.

d. Commence photo interpretation. Necessary photo interpretation equipment is as follows:

(1) Ideal: An Old Delft stereoscope (using the 4x setting for actual tree counts). Backlighting the prints on a light table while interpreting is helpful.

(2) Acceptable: A good quality mirror stereoscope with at least a 3x pair of binoculars. Again, backlighting the prints will help.

(3) Marginal: A pocket stereoscope, most of which have only a 2 - 2 1/2x magnification capability. A 4x pocket stereoscope would be much better. Backlighting would be of questionable value.

e. Record results and analyze.

E. RECOMMENDATIONS

Although the overall success of the forestry photo interpretive process was limited primarily because of competing vegetation obstructing the conifers, we believe that there is much potential for future success if larger photo scales and different times of photography acquisition are tried.

In other parts of the country, similar photo interpretive techniques have proven quite effective. Given the topographical and vegetational complexities of coastal Oregon, no remote sensing techniques will likely ever replace the need for on-the-ground data acquisition. However, the potential does exist to substantially supplement current and future ground data collection activities, thus saving a considerable amount of effort and funds (see Table 2).

TABLE 2

AVERAGE AERIAL PHOTOGRAPHY AND PHOTO INTERPRETATION COSTS
COOS BAY, EUGENE, ROSEBURG (3 SITES EACH)

Operational:

Aerial Photography (includes acquisition and processing)	$ 1,550.00*
Photo Interpretation Aids (includes photo overlays, rapidographs, etc.)	20.00
Total Operational	$ 1,570.00

Personnel:

Aerial Photography (planning, coordination)	7 hrs.
Photography Handling, Inspection, Set-up	8 hrs.
Photo Interpretation/Data Extraction (average number of hours for each of four interpreters, CIR only)	4 hrs.
Data Analysis	3 hrs.
Total Personnel Hours and Cost (assumes an average rate of $20.00 per hour)	$ 440.00
TOTAL OPERATIONAL AND PERSONNEL	$ 2,010.00
NINE SITES AVERAGE	$ 223.33

*Approximately half the mobilization costs have been subtracted to better represent the costs of acquiring photography for only nine sites. The average cost of $223.33 is also appropriate for a larger study area; i.e., a study area of several thousand square miles containing 200 plantation sites would cost $44,666 to acquire the photography and complete the interpretation.